AAPA-1

PATENT ABSTRACTS OF JAPAN

(11)Publication number : 11-274644

(43)Date of publication of application : 08.10.1999

(51)Int.Cl. H01S 3/18
H01L 33/00

(21)Application number : 10-070859

(22)Date of filing : 19.03.1998

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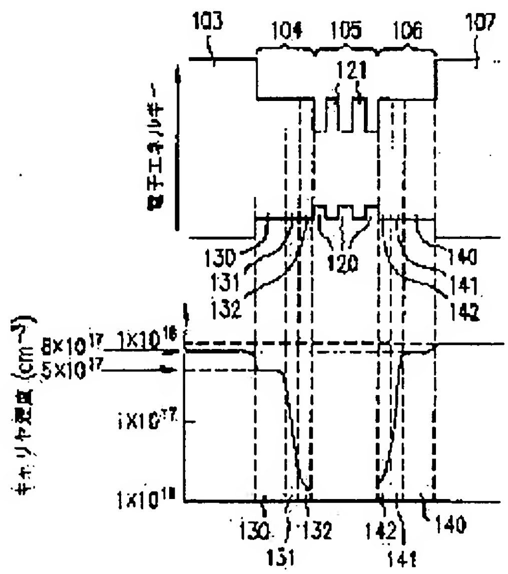
(54) SEMICONDUCTOR LIGHT EMITTING ELEMENT AND FABRICATION THEREOF

(57)Abstract:

PROBLEM TO BE SOLVED: To lower the working voltage while preventing deterioration of characteristics by providing at least one clad layer with a lean impurity region and an impurity added layer and arranging the lean impurity region on the side close to an active layer.

SOLUTION: A multiple quantum well active layer 105 comprises three AlGaAs quantum well active layers 120 and two AlGaAs quantum barrier layers (barrier layers) 12f being grown such that the barrier layer 121 is sandwiched by the quantum well active layers 120. A first optical guide layer 104 is formed by growing an impurity added layer and an impurity unadded layer from the n-type first clad layer 103 side. A second optical guide layer 106 is formed by growing an impurity unadded layer and an impurity added layer from the active layer 105 side. This structure can reduce working voltage, working current and element resistance.



LEGAL STATUS

[Date of request for examination] 26.01.2001

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]	
[Date of final disposal for application]	
[Patent number]	3429446
[Date of registration]	16.05.2003
[Number of appeal against examiner's decision of rejection]	
[Date of requesting appeal against examiner's decision of rejection]	
[Date of extinction of right]	

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to a semi-conductor light emitting device and its manufacture approaches, such as a semiconductor laser component and a light emitting diode component.
[0002]
[Description of the Prior Art] The quantum well mold laser which used the quantum well layer for the barrier layer which is a light-emitting part as a conventional semiconductor laser component is known. This quantum well mold laser can reduce the operating current, and has various advantages -- moreover a noise property is improvable.
[0003] In quantum well mold laser, there is structure (SCH:Separate Confinement Heterostructure) in slight discrete-type closing depth as structure where the slight closing depth of the light to a barrier layer can be increased.
[0004] By the way, generally aluminum mixed-crystal ratio and forbidden-band width of face of a compound semiconductor layer which generally have the relation of an inverse proportion and contain aluminum have the forbidden-band width of face and the refractive index of a compound semiconductor layer in proportionality.
[0005] It seems that therefore, the band diagram near [in the quantum well mold laser of SCH structure] the barrier layer is shown in drawing 11 .
[0006] The 1st lightguide layer 502 with larger forbidden-band width of face than the quantum well layer 510 and the 2nd lightguide layer 503 are formed across both the outsides of the multiplex quantum well (MQW:MultiQuantumWell) barrier layer 501 where this semiconductor laser component consists of two or more quantum well layers 510 and barrier layers 511. And the n-1st cladding layer 504 than 1st lightguide layer 502 and 2nd lightguide layer 503 and with larger forbidden-band width of face, and the p-2nd cladding layer 505 are formed across both the outside.
[0007] this semiconductor laser component -- setting -- a carrier -- shutting up -- it carries out in the quantum well layer 510 -- having -- light -- shutting up -- it is carried out in the 1st lightguide layer 502 and the 2nd lightguide layer 503.
[0008] Such a semiconductor laser component of SCH structure is indicated by JP,4-67354,B, JP,6-252508,A, etc.
[0009] Among these, with the semiconductor laser component of JP,4-67354,B, the impurity is added throughout the lightguide layer, and the impurity is not added throughout the lightguide layer with the semiconductor laser component of JP,6-252508,A.
[0010]
[Problem(s) to be Solved by the Invention] In above-mentioned SCH structure, by thickening thickness of a lightguide layer, light can shut up, effectiveness can improve and a low threshold current can be obtained. Therefore, in order to aim at current reduction, it is desirable to thicken thickness of a lightguide layer.

[0011] However, when the impurity is not added by the lightguide layer like the semiconductor laser component of JP,6-252508,A, layer resistance of a lightguide layer becomes large, and since a potential barrier arises between a cladding layer and a lightguide layer, there is a problem that operating voltage increases, further.
[0012] On the other hand, when the impurity is added by the lightguide layer like the semiconductor laser component of JP,4-67354,B, since an impurity is spread from a lightguide layer to a barrier layer and a nonluminescent recombination center is formed into a barrier layer during energization, an internal absorption loss arises, and there is a problem that a laser property deteriorates.
[0013] Furthermore, in the former, a detailed examination was hardly made about the effect the impurity addition to the semi-conductor layer which adjoins a barrier layer including a lightguide layer affects a laser property.
[0014] These things can say that the same is said of the light emitting diode component which is the same and prepared the cladding layer in the vertical both sides of a barrier layer further also with semiconductor laser components other than a quantum well mold laser component.
[0015] This invention is made that the technical problem of such a conventional technique should be solved, and while being able to reduce operating voltage, it aims at offering the semi-conductor light emitting device which can prevent property degradation, and its manufacture approach.
[0016]
[Means for Solving the Problem] In the semi-conductor light emitting device in which the semi-conductor light emitting device of this invention has a barrier layer and the cladding layer in which this barrier layer was prepared up and down, one [at least] cladding layer has an impurity rare field and an impurity addition field, it is allotted to the side with this impurity rare field near this barrier layer, and the above-mentioned purpose is attained by that.
[0017] In the semi-conductor light emitting device in which the semi-conductor light emitting device of this invention has a barrier layer and the lightguide layer in which this barrier layer was prepared up and down, one [at least] lightguide layer has an impurity rare field and an impurity addition field, it is allotted to the side with this impurity rare field near this barrier layer, and the above-mentioned purpose is attained by that.
[0018] In the semi-conductor light emitting device in which the semi-conductor light emitting device of this invention has a barrier layer and the lightguide layer prepared in vertical one side of this barrier layer, this lightguide layer has an impurity rare field and an impurity addition field, it is allotted to the side with this impurity rare field near this barrier layer, and the above-mentioned purpose is attained by that.
[0019] You may have the impurity middle concentration field between said impurity rare field and said impurity addition field.
[0020] Said barrier layer may consist of a quantum well layer.
[0021] When the impurity in said impurity addition field of said lightguide layer is p mold, it is desirable that the carrier concentration of this impurity is less than [more than 4x1017cm-31.2x10<SUP>18cm-3].
[0022] When the impurity in said impurity addition field of said lightguide layer is n mold, it is desirable that the carrier concentration of this impurity is three or less [3 or more / 2x1017cm - / cm / 1x1018 / -].
[0023] High impurity concentration in said impurity rare field can be made or less [of the high impurity concentration in said impurity addition field] into 1/5.
[0024] As for the thickness of said impurity rare field, it is desirable that it is [3nm or more] 10nm or less.
[0025] Said impurity rare field may be established in p mold cladding layer or p mold lightguide layer at least.
[0026] Although prepared in p mold cladding layer or p mold lightguide layer among said impurity rare fields, it is desirable that it is made thicker than thickness although thickness prepared in n mold cladding layer or n mold lightguide layer.

[0027] As for the thickness of said impurity middle concentration field, it is desirable that it is [3nm or more] 10nm or less.
[0028] said barrier layer consists of multiplex quantum well layers which consist of two or more quantum well layers and a barrier layer inserted in these two or more quantum well layers, and can set in the lightguide layer which has said impurity rare field and said impurity addition field -- forbidden-band width of face of an impurity addition field may be made at least larger than the forbidden-band width of face of this quantum well layer smaller than the forbidden-band width of face of this barrier layer.
[0029] In said lightguide layer, forbidden-band width of face of said impurity addition field may be made smaller than the forbidden-band width of face of said impurity rare field.
[0030] Said cladding layer or said lightguide layer may consist of the AlGaAs system ingredient, an AlGaInP system ingredient, or an InGaN system ingredient.
[0031] The manufacture approach of the semi-conductor light emitting device of this invention is an approach of manufacturing the semi-conductor light emitting device of this invention, an impurity addition layer and an impurity additive-free layer are grown up, an impurity is diffused from this impurity addition layer to an impurity additive-free layer by the heat history in crystal growth, said impurity middle concentration field is formed, and the above-mentioned purpose is attained by that.
[0032] Although are prepared in p mold cladding layer or p mold lightguide stratification section among said impurity additive-free layers and thickness was prepared in n mold cladding layer or n mold lightguide stratification section, it is desirable to make it thicker than thickness.
[0033] Hereafter, an operation of this invention is explained.
[0034] If it is in this invention, since at least one side of the cladding layer in which the barrier layer was prepared up and down has an impurity rare field and an impurity addition field and the impurity rare field where high impurity concentration is lower than an impurity addition field is allotted to the side near a barrier layer, it can control that an impurity is spread from an impurity addition field during energization at a barrier layer in an impurity rare field.
[0035] If it is in other this inventions, since at least one side of a lightguide layer in which the barrier layer was prepared up and down has an impurity addition field, resistance of the whole lightguide layer can be lowered, and further, since the diffusion potential between a lightguide layer and a cladding layer can be reduced, operating voltage can be reduced. Furthermore, since the impurity rare field where high impurity concentration is lower than an impurity addition field is allotted to the side near a barrier layer, during energization, it can control that an impurity is spread in a barrier layer in an impurity rare field from an impurity addition field, and the dependability of a component can be raised.
[0036] If it is in other this inventions, since the lightguide layer prepared in vertical one side of a barrier layer has an impurity addition field, resistance of the whole lightguide layer can be lowered, and further, since the diffusion potential between a lightguide layer and a cladding layer can be reduced, operating voltage can be reduced. Furthermore, since the impurity rare field where high impurity concentration is lower than an impurity addition field is allotted to the side near a barrier layer, during energization, it can control that an impurity is spread in a barrier layer in an impurity rare field from an impurity addition field, and the dependability of a component can be raised.
[0037] Furthermore, since it can protect that an impurity is spread to an impurity rare field from an impurity addition field during energization by high impurity concentration being lower than an impurity addition field between the above-mentioned impurity rare field and an impurity addition field, and establishing an impurity middle concentration field higher than an impurity rare field in it, the dependability of a component can be raised further.
[0038] When a barrier layer consists of a quantum well layer especially, layer structure changes and it is easy to produce property degradation also by the slight impurity diffusion under energization, but since the impurity diffusion to the barrier layer under energization can be controlled according to this invention, it is very effective.
[0039] When the impurity in the impurity addition field of the above-mentioned lightguide layer is p mold, it is desirable to set the carrier concentration of an impurity or less [3 or more / 4x1017cm - / cm / 1.2x1018 / -] to three. Moreover, when the impurity in the impurity addition field of the above-

mentioned lightguide layer is n mold, it is desirable to set the carrier concentration of an impurity or less [3 or more / 2x1017cm - / cm / 1x1018 / -] to three. While reducing operating voltage effectively by setting it as this range, property degradation by the nonluminescent recombination of the carrier in an impurity addition field can be controlled effectively. In addition, what is necessary is just the concentration which has a carrier ****** function to a barrier layer as a cladding layer about the high impurity concentration in the impurity addition field of a cladding layer.

[0040] If the carrier concentration of the impurity in the above-mentioned impurity rare field is 1/5 or less [of the carrier concentration of the impurity in an impurity addition field], it can control effectively the impurity diffusion to the barrier layer under energization.

[0041] As for the thickness of the above-mentioned impurity rare field, it is desirable that it is [3nm or more] 10nm or less. Since the carrier injection from an impurity addition field to a barrier layer is checked for a potential barrier when there is a possibility that an impurity may be spread in a barrier layer and may cause property degradation during energization in less than 3nm and it exceeds 10nm, there is a possibility that operating voltage may become high. In addition, what is necessary is just thickness required for optical confinement in the case of a lightguide layer that what is necessary is just thickness required for eye carrier ****** to a barrier layer as a cladding layer in the case of a cladding layer about the thickness of an impurity addition field.

[0042] The above-mentioned impurity rare field may be established only in p mold cladding layer or p mold lightguide layer side. p mold impurity has a diffusion coefficient larger than n mold impurity, and it is because an impurity is spread in a barrier layer and it is easy to produce property degradation. In this case, since what is necessary is just to perform thickness control of the impurity rare field of p mold, a component design is easy.

[0043] Or although are prepared in p mold cladding layer or p mold lightguide layer among the above-mentioned impurity rare fields and thickness was prepared in n mold cladding layer or n mold lightguide layer, you may make it thicker than thickness. In this case, since the thickness of an impurity rare field is controllable according to that diffusion degree to p mold impurity with a bigger diffusion coefficient than n mold impurity, the controllability over a component design can be raised.

[0044] As for the thickness of the above-mentioned impurity middle concentration field, it is desirable that it is [3nm or more] 10nm or less. If it is set as this range, during energization, it can protect that an impurity is spread to an impurity rare field from an impurity addition field effectively, and carrier injection to a barrier layer will not be prevented from an impurity addition field.

[0045] when the above-mentioned barrier layer consists of a multiplex quantum well layer, it can set in a lightguide layer -- forbidden-band width of face of an impurity addition field may be made at least larger than the forbidden-band width of face of a quantum well layer smaller than the forbidden-band width of face of a barrier layer. Generally aluminum mixed-crystal ratio and forbidden-band width of face containing aluminum of a semi-conductor layer are in proportionality, and since aluminum mixed-crystal ratio can be made small by reducing the forbidden-band width of face of an impurity addition field, the impurity diffusion from an impurity addition field to a barrier layer can be reduced further. Furthermore, since the impurity diffusion from an impurity addition field to a barrier layer is reduced, the thickness of an impurity rare field can be set up thinly, and it is effective also to operating voltage reduction.

[0046] Here, although the forbidden-band width of face may be made larger than the forbidden-band width of face of a quantum well layer smaller than the forbidden-band width of face of a barrier layer about the whole lightguide layer including an impurity rare field or an impurity middle concentration field, if forbidden-band width of face of an impurity addition field is made smaller than the forbidden-band width of face of an impurity rare field, slight carrier closing depth to a barrier layer can be performed in an impurity rare field. Therefore, aluminum mixed-crystal ratio of an impurity addition field can be made still smaller, and the impurity diffusion from an impurity addition field to a barrier layer can be reduced further. Furthermore, since the impurity diffusion from an impurity addition field to a barrier layer can be reduced, the thickness of an impurity rare field can be set up thinly and it is effective also to operating voltage reduction.

[0047] The above-mentioned cladding layer or a lightguide layer may be an AlGaAs system ingredient, an AlGaInP system ingredient, or an InGaN system ingredient. Since it is especially easy to diffuse an impurity compared with an AlGaAs system ingredient with an AlGaInP system ingredient, it is effective. Furthermore, since growth temperature is high compared with an AlGaInP system ingredient and it is easy to produce diffusion of an impurity with an InGaN system ingredient, it is effective.
[0048] If it is in this invention, since an impurity is diffused from an impurity addition layer to an impurity additive-free layer by the heat history in crystal growth and the above-mentioned impurity middle concentration field is formed, an impurity addition field, an impurity middle concentration field, and an impurity rare field can be created in a brief manufacture process with a sufficient controllability. For example, in an AlGaAs system ingredient, although it is 600 degrees C - 800 degrees C, and the temperature (crystal growth temperature) of the heat history at this time is 500 degrees C - 700 degrees C with an AlGaInP system ingredient and is 900 degrees C - 1100 degrees C with an InGaN system ingredient, in order to control diffusion, it may form an impurity middle concentration field at temperature lower about 50 degrees C - about 200 degrees C than the growth temperature of a barrier layer.
[0049] Although are prepared in p mold cladding layer or p mold lightguide stratification section among the above-mentioned impurity additive-free layers and thickness was prepared in n mold cladding layer or n mold lightguide stratification section, you may make it thicker than thickness. In this case, since the thickness of an impurity rare field is controllable by controlling the thickness of an impurity additive-free field according to that diffusion degree to p mold impurity with a bigger diffusion coefficient than n mold impurity, the controllability over a component design can be raised.
[0050]
[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained, referring to a drawing.
[0051] (Operation gestalt 1) This operation gestalt 1 explains the example which applied this invention to the ridge mold semiconductor laser component.
[0052] Drawing 1 is the sectional view of the semiconductor laser component of the operation gestalt 1.
[0053] As for this semiconductor laser component, laminating formation of the n-GaAs buffer layer 102, the 1st cladding layer 103 of n-aluminum0.5Ga0.5As, the 1st lightguide layer 104 of aluminum0.35Ga0.65As, the non dope multiplex quantum well barrier layer 105, the 2nd lightguide layer 106 of aluminum0.35Ga0.65As, the 2nd cladding layer 107 of p-aluminum0.5Ga0.5As, and the p-GaAs etching stop layer 108 is carried out on the n-GaAs substrate 101. On the center section of the etching stop layer 108, the 3rd cladding layer 109 of p-aluminum0.5Ga0.5As and the p-GaAs cap layer 110 of a ridge stripe are prepared. The both-sides top n-aluminum0.7Ga0.3As current optical confinement layer 111 of the center section of the etching stop layer 108, the n-GaAs current blocking layer 112, and the p-GaAs flattening layer 113 are formed so that the both sides of this ridge stripe may be embedded. The p-GaAs contact layer 114 is formed over the cap layer 110 and flattening layer 113 top on it. p mold electrode 150 is formed on the p-GaAs contact layer 114, and n mold electrode 151 is formed in the semi-conductor layer growth side of a substrate 101, and the field of the opposite side.
[0054] This semiconductor laser component is the following, and can be made and produced.
[0055] first, the n-GaAs substrate 101 top -- 1st MOCVD -- by law (metal-organic chemical vapor deposition) the n-GaAs buffer layer 102 (micrometers [of thickness / 0.5], and Dopant Si --) Carrier concentration 1x1018cm-3, the 1st cladding layer 103 (1.5 micrometers of thickness) of n-aluminum0.5Ga0.5As Dopant Si, carrier concentration 8x1017cm-3, the 1st lightguide layer 104 of aluminum0.35Ga0.65As, the non dope multiplex quantum well barrier layer 105, the 2nd lightguide layer 106 of aluminum0.35Ga0.65As, and the 2nd cladding layer 107 (micrometers [of thickness / 0.25], and Dopant Zn --) of p-aluminum0.5Ga0.5As Carrier concentration 1x1018cm-3, the p-GaAs etching stop layer 108 (0.003 micrometers of thickness) Dopant Zn, carrier concentration 1x1018cm-3, the 3rd cladding layer 109 (1.0 micrometers of thickness) of p-aluminum0.5Ga0.5As Dopant Zn, carrier concentration 2x1018cm-3, and the p-GaAs cap layer 110 (micrometers [of thickness / 0.7], Dopant Zn, carrier concentration 3x1018cm-3) are grown up.

[0056] Here, as shown in drawing 2 , the multiplex quantum well barrier layer 105 grew up the three-layer aluminum0.12Ga0.88As quantum well layer 120 (0.008 micrometers of thickness), and the two-layer aluminum0.35Ga0.65As quantum barrier layer (barrier layer) 121 (0.005 micrometers of thickness) so that a barrier layer 121 might be inserted in the multiplex quantum well layer 120. And the 1st lightguide layer 104 grew up the impurity addition layer (0.03 micrometers of thickness, Dopant Si, carrier concentration 5x1017cm-3), and the impurity non-adding layer (0.02 micrometers of thickness) from the n-1st cladding layer 103 side. Furthermore, the 2nd lightguide layer 106 grew up the impurity non-adding layer (0.02 micrometers of thickness), and the impurity addition layer (0.03 micrometers of thickness, Dopant Zn, carrier concentration 8x1017cm-3) from the barrier layer 105 side.
[0057] Next, the cap layer 110 is processed into a convex stripe (top-face width of face of 2 micrometers) by using a stripe-like resist pattern as a mask. The p-3rd cladding layer 109 is processed into a ridge stripe (bottom surface width of 2.5 micrometers) by using the cap layer 110 of this convex stripe as a mask. At this time, etching stops in the etching stop layer 108 on both the outsides of a ridge stripe. A resist is removed after etching termination.
[0058] then, 2nd MOCVD -- the n-aluminum0.7Ga0.3As current optical confinement layer 111 (micrometers [of thickness / 0.6], Dopant Si, carrier concentration 1x1018cm-3), the n-GaAs current blocking layer 112 (micrometers [of thickness / 0.3], Dopant Si, carrier concentration 1x1018cm-3), and the p-GaAs flattening layer 113 (micrometers [of thickness / 0.3], Dopant Zn, carrier concentration 1x1018cm-3) are grown up so that a ridge stripe may be embedded by law.
[0059] then, the unnecessary layer which grew up to be right above [of the cap layer 110] -- etching -- removing -- the cap layer 110 -- the thickness of 0.3 micrometers -- adjusting -- 3rd MOCVD -- the p-GaAs contact layer 114 (micrometers [of thickness / 3], Dopant Zn, carrier concentration 1x1019cm-3) is grown up over the cap layer 110 and flattening layer 113 top by law.
[0060] The impurity diffusion from an impurity addition layer to impurity a non-adding layer happens, and it seems for the heat history temperature under above-mentioned MOCVD growth (crystal growth temperature) to be 600 degrees C - 800 degrees C, and for this to show the band diagram near the barrier layer, and distribution of carrier concentration to drawing 2 in the 1st lightguide layer 104 and the 2nd lightguide layer 106.
[0061] That is, the 1st lightguide layer 104 is divided into the impurity addition field 130 (0.03 micrometers of thickness), the impurity middle concentration field 131 (0.01 micrometers of thickness), and the impurity rare field 132 (0.01 micrometers of thickness) whose high impurity concentration is 1/5 or less concentration of the impurity addition field 130 from the n-1st cladding layer 103 side. On the other hand, the 2nd lightguide layer 106 is divided into the impurity addition field 140 (0.03 micrometers of thickness), the impurity middle concentration field 141 (0.01 micrometers of thickness), and the impurity rare field 142 (0.01 micrometers of thickness) whose high impurity concentration is 1/5 or less concentration of the impurity addition field 140 from the p-2nd cladding layer 107 side. Therefore, an impurity addition field, an impurity middle concentration field, and an impurity rare field are produced in a brief process with a sufficient controllability by the heat history in the crystal growth of a semi-conductor layer.
[0062] Finally, p mold electrode 150 and n mold electrode 151 are respectively formed on a growth phase and the external surface of a substrate 101. Here, the cavity length of a semiconductor laser component sets to 375 micrometers, the end face by the side of optical outgoing radiation makes a reflection factor 10% by monolayer coating of aluminum 2O3, and the end face of the opposite side makes a reflection factor 75% by multilayers coating of aluminum2O3 and Si.
[0063] Thus, about the semiconductor laser component of this operation gestalt 1 acquired, the component property at the time of making it operate by 4mW of optical outputs at a room temperature is shown in the following table 1. The component property is shown in the following table 1 also about the semiconductor laser component of the example 2 of a comparison produced like the operation gestalt 1 except having added the impurity throughout the semiconductor laser component of the example 1 of a comparison produced like the operation gestalt 1, and the lightguide layer except having not added an impurity throughout the lightguide layer for the comparison.

[0064]
[Table 1]

素子特性

	動作電流	動作電圧	素子抵抗
実施形態1	20mA	1.80V	5オーム
比較例1	20mA	2.10V	15オーム
比較例2	25mA	1.80V	5オーム

[0065] As shown in this table 1, with this operation gestalt 1, operating voltage, the operating current, and component resistance can be reduced. On the other hand, although the semiconductor laser component of the example 1 of a comparison which did not add an impurity throughout the lightguide layer can reduce the operating current like the semiconductor laser component of this operation gestalt 1, since resistance of a lightguide layer becomes large, component resistance increases, and since a potential barrier arises between a cladding layer and a lightguide layer further, operating voltage increases. Moreover, although the semiconductor laser component of the example 2 of a comparison which added the impurity throughout the lightguide layer can reduce operating voltage and component resistance like the semiconductor laser component of this operation gestalt 1, a laser property deteriorates by the impurity diffusion from the lightguide layer under energization to a barrier layer, and the operating current increases.
[0066] The carrier concentration of the impurity addition field of the 1st lightguide layer 104 is fixed to 5x1017cm-3 at drawing 3 , and change of the operating voltage when changing the carrier concentration of the impurity addition field of the 2nd lightguide layer 106 is shown. Moreover, the carrier concentration of the impurity addition field of the 2nd lightguide layer 106 is fixed to 8x1017cm-3 at drawing 4 , and change of the operating voltage when changing the carrier concentration of the impurity addition field of the 1st lightguide layer 104 is shown.
[0067] While the carrier concentration of an impurity addition field increases so that this drawing 3 and drawing 4 may show, operating voltage is decreasing.
[0068] For example, since the carrier concentration of the 1st lightguide layer 104 can reduce operating voltage less than [1.9V] if it is set or more [2x1017cm -] to three as shown in drawing 4 , it is desirable. However, since a nonluminescent core peculiar to n mold impurity will generate, luminous efficiency will fall in the 1st lightguide layer 104 and degradation of a laser property will be caused if the carrier concentration of the 1st lightguide layer 104 is too large, as for the carrier concentration of the 1st lightguide layer 104, it is desirable to set or less [1x1018cm -] to three.
[0069] On the other hand, since the carrier concentration of the 2nd lightguide layer 106 can reduce operating voltage less than [1.9V] if it is set or more [4x1017cm -] to three as shown in drawing 3 , it is desirable. However, since the current flare in the 2nd lightguide layer 106 will increase and increase of the threshold current by the increment in the reactive current will be caused if the carrier concentration of the 2nd lightguide layer 106 is too large, as for the carrier concentration of the 2nd lightguide layer 106, it is desirable to set or less [1.2x1018cm -] to three.
[0070] If the thickness of the impurity rare field of the lightguide layers 104 and 106 is too thick not much, since the carrier injection from an impurity addition field to a multiplex quantum well barrier layer will be checked here for a potential barrier, it is desirable to set to the less than thickness which is extent to which a carrier carries out tunneling of this potential barrier, and carrier injection is performed smoothly, for example, 10nm. However, in less than 3nm, during energization, an impurity is spread in a barrier layer and the thickness of an impurity rare field causes property degradation. Therefore, it is desirable to set the thickness of an impurity rare field as 3nm or more. If the carrier concentration of the impurity in this impurity rare field is 1/5 or less [of the carrier concentration of the impurity in an impurity addition field], it can control effectively the impurity diffusion to the barrier layer under energization.
[0071] Furthermore, since the impurity diffusion from the impurity addition field under energization to a barrier layer can be controlled in the field of both an impurity middle concentration field and an

impurity rare field by preparing the impurity middle concentration field by impurity diffusion between an impurity addition field and an impurity rare field, it is further effective to prevention of property degradation. And since a potential barrier can be eased since a potential barrier changes continuously in an impurity middle concentration field, consequently carrier injection to a barrier layer can be performed smoothly, operating voltage can be reduced further. As for the thickness of this impurity middle concentration field, it is desirable that it is [3nm or more] 10nm or less. If it is set as this range, during energization, it can protect that an impurity is spread to an impurity rare field from an impurity addition field effectively, and carrier injection to a barrier layer will not be prevented from an impurity addition field.

[0072] (Operation gestalt 2) This operation gestalt 2 explains the example which made smaller than the forbidden-band width of face of a barrier layer forbidden-band width of face of a lightguide layer larger than the forbidden-band width of face of a quantum well layer.

[0073] Drawing 5 is the sectional view of the semiconductor laser component of the operation gestalt 2.

[0074] This semiconductor laser component On the n-GaAs substrate 201, the n-Ga0.5In0.5P buffer layer 202, the n-(aluminum0.7Ga0.3)0.5In0.5P 1st cladding layer 203, the 0.5(aluminum0.7Ga0.3) In0.5P 1st lightguide layer 204, the non dope multiplex quantum well barrier layer 205, (aluminum0.7Ga0.3) Laminating formation of the p-(aluminum0.7Ga0.3)0.5In0.5P 2nd cladding layer 207 which has the 0.5In0.5P 2nd lightguide layer 206 and ridge stripe 209 part, and a flat part is carried out. On ridge stripe 209 part of the p-2nd cladding layer 207, the p-Ga0.5In0.5P cap layer 208 is formed. The layer 210 is formed in slight n-GaAs current light closing depth on the flat part of the p-2nd cladding layer 207 so that the both sides of this ridge stripe 209 may be embedded. p mold electrode 212 is formed over a layer 210 top in the slight cap layer 208 and current light closing depth on it, and n mold electrode 211 is formed in the semi-conductor layer growth side of a substrate 201, and the field of the opposite side.

[0075] This semiconductor laser component is the following, and can be made and produced.

[0076] first, the n-GaAs substrate 201 top -- MOCVD -- law -- the n-Ga0.5In0.5P buffer layer 202, and the n-(aluminum0.7Ga0.3)0.5In0.5P 1st cladding layer 203 (1.5 micrometers of thickness) -- The 0.5In0.5P 2nd lightguide layer 204, the non dope multiplex quantum well barrier layer 205, the 0.5 (aluminum0.7Ga0.3) In0.5P 2nd lightguide layer 206, the p-(aluminum0.7Ga0.3)0.5In0.5P 2nd cladding layer 207 (aluminum0.7Ga0.3) (1.5 micrometers of thickness) And the p-Ga0.5In0.5P cap layer 208 (0.3 micrometers of thickness) is grown up.

[0077] Here, as shown in drawing 6 , the multiplex quantum well barrier layer 205 grew up the three-layer Ga0.5In0.5P quantum well layer 220 (0.008 micrometers of thickness), and the two-layer 0.5 (aluminum0.5Ga0.5) In0.5P barrier layer 221 (0.005 micrometers of thickness) so that a barrier layer 221 might be inserted in the multiplex quantum well layer 220. And the 1st lightguide layer 204 grew up the impurity addition layer (0.015 micrometers of thickness, Dopant Si, carrier concentration 7x1017cm-3), and the impurity non-adding layer (0.02 micrometers of thickness) from the n-1st cladding layer 203 side. Furthermore, the 2nd lightguide layer 206 grew up the impurity non-adding layer (0.02 micrometers of thickness), and the impurity addition layer (0.015 micrometers of thickness, Dopant Zn, carrier concentration 1x1018cm-3) from the barrier layer 205 side.

[0078] The impurity diffusion from an impurity addition layer to impurity a non-adding layer happens, and it seems for the heat history temperature under above-mentioned MOCVD growth (crystal growth temperature) to be 500 degrees C - 700 degrees C, and for this to show the band diagram near the barrier layer to drawing 6 in the 1st lightguide layer 204 and the 2nd lightguide layer 206.

[0079] That is, the 1st lightguide layer 204 is divided into the impurity addition field 230 (0.01 micrometers of thickness), the impurity middle concentration field 231 (0.015 micrometers of thickness), and the impurity rare field 232 (0.01 micrometers of thickness) from the n-1st cladding layer 203 side. On the other hand, as for the 2nd lightguide layer 206, the impurity addition field 240 (0.01 micrometers of thickness), the impurity middle concentration field 241 (0.015 micrometers of thickness), and high impurity concentration are divided into the impurity rare field 242 (0.01 micrometers of thickness) from the p-2nd cladding layer 207 side. Therefore, an impurity addition field,

an impurity middle concentration field, and an impurity rare field are produced in a brief process with a sufficient controllability by the heat history in the crystal growth of a semi-conductor layer.
[0080] Next, the p-2nd cladding layer 207 and, and the cap layer 208 are etched, etching is stopped and the ridge stripe 209 with a width of face of 5 micrometers is formed so that the remnants thickness of the flat part of the p-2nd cladding layer 207 may be set to 0.3 micrometers.
[0081] Then, the n-GaAs current optical confinement layer 210 (1.2 micrometers of thickness) is grown up so that both the outsides of the ridge stripe 209 may be embedded by the MOCVD method.
[0082] Finally, p mold electrode 212 and n mold electrode 211 are respectively formed on a growth phase and the external surface of a substrate 201. Here, the cavity length of a semiconductor laser component sets to 500 micrometers by the cleavage method, the end face by the side of the optical outgoing radiation of a resonator makes a reflection factor 50%, and the end face of the opposite side makes a reflection factor 85%.
[0083] Thus, as shown in drawing 6 , the semiconductor laser component of this operation gestalt 2 acquired has the forbidden-band width of face of the 1st lightguide layer 204 and the 2nd lightguide layer 206 larger than the forbidden-band width of face of the quantum well layer 220, and is set up smaller than the forbidden-band width of face of a barrier layer 221. Since aluminum mixed-crystal ratio and forbidden-band width of face containing aluminum of a semi-conductor layer generally have a proportional relation, it is larger than aluminum mixed-crystal ratio (x= 0) of the quantum well layer 220 of the multiplex quantum well barrier layer 205, and aluminum mixed-crystal ratio (x= 0.3) of the 1st lightguide layer 204 and the 2nd lightguide layer 206 is set up smaller than aluminum mixed-crystal ratio (x= 0.5) of a barrier layer 221. Thereby, aluminum mixed-crystal ratio of the impurity addition field of a lightguide layer can be set up comparatively small. Therefore, the impurity diffusion from an impurity addition field to a barrier layer can be reduced further, and effectiveness is in prevention of property degradation further.
[0084] Furthermore, since the impurity diffusion from an impurity addition field to a barrier layer can be reduced further, even if it makes thickness of an impurity rare field thin, the impurity diffusion from the impurity addition field under energization to a barrier layer can be controlled. Therefore, since thickness of an impurity rare field can be made thin and current impregnation to a barrier layer from a lightguide layer can be made smooth, operating voltage can be reduced.
[0085] Furthermore, since the forbidden-band width of face and the refractive index of a compound semiconductor layer generally have the relation of an inverse proportion, the refractive index of the whole lightguide layer becomes high, light closes, eye ** increases, and reduction of a threshold current can be aimed at.
[0086] When forward voltage is impressed between n mold electrode 211 and p mold electrode 212 to the semiconductor laser component of this operation gestalt 2, the component properties at the time of making it operate by slope effectiveness 0.6 W/A and 3mW of optical outputs of the oscillation wavelength of 0.65 micrometers, the threshold current of 30mA, and a current-optical output property are 35mA of operating currents, and operating voltage 2V. On the other hand, when an impurity is not added throughout a lightguide layer, operating voltage increases to 2.3V, and when an impurity is added throughout a lightguide layer, although operating voltage is 2V, the operating current increases to 50mA by the impurity diffusion from the lightguide layer under energization to a barrier layer. Thus, with this operation gestalt 2, while reducing operating voltage, property degradation by operating current increase can be prevented.
[0087] (Operation gestalt 3) This operation gestalt 3 explains the example which made smaller than the forbidden-band width of face of a barrier layer forbidden-band width of face of the impurity addition field of a lightguide layer larger than the forbidden-band width of face of a quantum well layer, and made forbidden-band width of face of an impurity rare field larger than the forbidden-band width of face of an impurity addition field.
[0088] In this semiconductor laser component, the structure of a semiconductor laser component is the same as the operation gestalt 2 shown in drawing 5 .
[0089] It seems that and the impurity diffusion from an impurity addition layer to impurity a non-adding

layer happens in the 1st lightguide layer 204 and the 2nd lightguide layer 206 by the heat history in crystal growth, and the band diagram near the barrier layer is shown in drawing 7 with this operation gestalt 3 as well as the operation gestalt 2.

[0090] That is, the 1st lightguide layer 204 is divided into the impurity addition field 250 (0.01 micrometers of thickness), the impurity middle concentration field 251 (0.015 micrometers of thickness), and the impurity rare field 252 (0.01 micrometers of thickness) from the n-1st cladding layer 203 side. On the other hand, as for the 2nd lightguide layer 206, the impurity addition field 260 (0.01 micrometers of thickness), the impurity middle concentration field 261 (0.015 micrometers of thickness), and high impurity concentration are divided into the impurity rare field 262 (0.01 micrometers of thickness) from the p-2nd cladding layer 207 side. Thus, an impurity addition field, an impurity middle concentration field, and an impurity rare field are produced in a brief process with a sufficient controllability by the heat history in the crystal growth of a semi-conductor layer.

[0091] Here, with this operation gestalt 3, aluminum mixed-crystal ratio of the impurity addition field 250 of the 1st lightguide layer 204 and the impurity addition field 260 of the 2nd lightguide layer 206 is set to 0.2 or 0.3, and it is larger than aluminum mixed-crystal ratio (x= 0) of the quantum well layer 220 of the multiplex quantum well barrier layer 205, and sets up smaller than aluminum mixed-crystal ratio (x= 0.5) of a barrier layer 221. That is, as shown in drawing 7 , it is larger than the forbidden-band width of face of the quantum well layer 220, and the forbidden-band width of face of the impurity addition field 250 of the 1st lightguide layer 204 and the impurity addition field 260 of the 2nd lightguide layer 206 is set up smaller than the forbidden-band width of face of a barrier layer 221. On the other hand, aluminum mixed-crystal ratio (x= 0.5) of the impurity rare field 252 of the 1st lightguide layer 204 and the impurity rare field 262 of the 2nd lightguide layer 206 is set up more greatly than aluminum mixed-crystal ratio (x= 0.2 or 0.3) of the impurity addition field 250 of the 1st lightguide layer 204, and the impurity addition field 260 of the 2nd lightguide layer 206. That is, as shown in drawing 7 , the forbidden-band width of face of the impurity rare field 252 of the 1st lightguide layer 204 and the impurity rare field 262 of the 2nd lightguide layer 206 is set up more greatly than the forbidden-band width of face of the impurity addition field 250 of the 1st lightguide layer 204, and the impurity addition field 260 of the 2nd lightguide layer 206. By this, the carrier to a barrier layer can close, eye ** can be performed in an impurity rare field, and aluminum mixed-crystal ratio of the impurity addition field of a lightguide layer can be set up still smaller than the operation gestalt 2. Therefore, the impurity diffusion from an impurity addition field to a barrier layer can be further reduced rather than the operation gestalt 2, and effectiveness is in prevention of property degradation further.

[0092] The forbidden-band width of face of the impurity addition fields 250 and 260 is larger than the forbidden-band width of face of the quantum well layer 220 at least here. That what is necessary is to just be set up smaller than the forbidden-band width of face of a barrier layer 221 about the forbidden-band width of face of the impurity middle concentration fields 251 and 261 As shown in drawing 7 , it may be made the same forbidden-band width of face as the impurity rare fields 252 and 262, and as shown in drawing 8 , you may make it the same forbidden-band width of face as the impurity addition fields 250 and 260. Or you may make it the middle forbidden-band width of face of an impurity rare field and an impurity addition field.

[0093] In addition, since it is the ingredient which an impurity tends to diffuse compared with an AlGaAs system ingredient with the AlGaInP system ingredient shown with the above-mentioned operation gestalten 2 and 3, it is very effective to apply this invention which can reduce the impurity diffusion from an impurity addition field to a barrier layer.

[0094] (Operation gestalt 4) This operation gestalt 4 explains the example which applied this invention to the light emitting diode component.

[0095] Drawing 9 is the sectional view of the semiconductor laser component of the operation gestalt 4.

[0096] As for this semiconductor laser component, laminating formation of the GaN buffer layer 302 and the 1st cladding layer 303 of n-GaN, the non dope single quantum well (SQW:Single Quantum Well) barrier layer 305, the 2nd cladding layer 305 of aluminum0.2Ga0.8N, and the p-GaN contact layer 306 is carried out on silicon on sapphire 301. The n-1st cladding layer 303, a barrier layer 304, the 2nd

cladding layer 305, and the contact layer 306 are formed in the mesa stripe 313 for which the n-1st cladding layer 303 was exposed in part. And n mold electrode 320 is formed on the outcrop of the n-1st cladding layer 303, and p mold electrode 321 is formed on the contact layer 306.
[0097] This semiconductor laser component is the following, and can be made and produced.
[0098] first, a silicon-on-sapphire 301 top -- MOCVD -- the GaN buffer layer 302 (0.05 micrometers of thickness), the 1st cladding layer 303 (micrometers [of thickness / 3], Dopant Si, carrier concentration 5x1018cm-3) of n-GaN, the non dope single quantum well barrier layer 304, the 2nd cladding layer 305 of aluminum0.2Ga0.8N, and the p-GaN contact layer 306 (micrometers [of thickness / 0.2], Dopant Mg, carrier concentration 5x1017cm-3) are grown up by law.
[0099] Here, the single quantum well barrier layer 305 grew up the Ga0.2In0.8P quantum well layer (0.003 micrometers of thickness) of a monolayer. And the 2nd cladding layer 305 grew up the impurity non-adding layer (0.03 micrometers of thickness), and the impurity addition layer (0.07 micrometers of thickness, Dopant Mg, carrier concentration 5x1017cm-3) from the barrier layer 304 side.
[0100] The heat history temperature under above-mentioned MOCVD growth (crystal growth temperature) is 900 degrees C - 1100 degrees C, and thereby, in the 2nd cladding layer 305, the impurity diffusion from an impurity addition layer to impurity a non-adding layer happens, and it is divided into the impurity rare field 310 (0.01 micrometers of thickness), the impurity middle concentration field 311 (0.04 micrometers of thickness), and the impurity addition field 312 (0.05 micrometers of thickness) from a barrier layer 304 side. Therefore, an impurity addition field, an impurity middle concentration field, and an impurity rare field are produced in a brief process with a sufficient controllability by the heat history in the crystal growth of a semi-conductor layer.
[0101] Then, the resist mask of a circle configuration is formed in a front face, the mesa stripe 313 is formed by dry etching, and n mold electrode 320 and p mold electrode 321 are respectively formed on the outcrop of the n-1st cladding layer 303, and the contact layer 306.
[0102] Thus, as for the light emitting diode component of this operation gestalt 4 acquired, the impurity rare field 310 is established in p mold cladding layer side. Since the diffusion coefficient is larger than n mold impurity, when the direction of p mold impurity controls the diffusion to the barrier layer of the impurity by the side of p mold cladding layer (Mg) by the impurity rare field, reduction of operating voltage and property degradation prevention can be aimed at. Furthermore, since optimization of a property can be attained only by controlling the thickness of the impurity rare field by the side of p mold cladding layer in this case, it has the advantage that a design is easy.
[0103] When forward voltage was impressed between n mold electrode 320 and p mold electrode 321 to the light emitting diode component of this operation gestalt 4, the luminescence wavelength of 0.45 micrometers, 50mA of operating currents, and operating voltage 4.5V were obtained. And since the impurity diffusion from the 2nd cladding layer under energization to a barrier layer can be controlled, degradation of a component property can be prevented. On the other hand, although operating voltage is 4.5V when an impurity is added throughout the 2nd cladding layer, property degradation arises during energization. Thus, property degradation can be prevented with this operation gestalt 4, without increasing operating voltage.
[0104] In addition, since growth temperature is [ingredient / which was shown in this operation gestalt / InGaN system / the growth temperature of 600 degrees C - 700 degrees C of an AlGaAs system ingredient or an AlGaInP system ingredient] as high as 1000 degrees C **100 degrees C, the degree of impurity diffusion is large. Therefore, it is very effective to apply this invention which can reduce the impurity diffusion from a cladding layer to a barrier layer.
[0105] (Operation gestalt 5) This operation gestalt 5 explains the example which established the impurity rare field in the side which adjoins the barrier layer of p mold cladding layer and n mold cladding layer.
[0106] Drawing 10 is the sectional view of the semiconductor laser component of the operation gestalt 5.
[0107] As for this semiconductor laser component, laminating formation of the GaN buffer layer 402 and the 1st cladding layer 403 of GaN, the non dope single quantum well barrier layer 404, the 2nd

cladding layer 405 of aluminum0.2Ga0.8N, and the p-GaN contact layer 406 is carried out on silicon on sapphire 401. The n-1st cladding layer 403, a barrier layer 404, the 2nd cladding layer 405, and the contact layer 406 are formed in the mesa stripe 413 for which the 1st cladding layer 403 was exposed in part. And n mold electrode 420 is formed on the outcrop of the 1st cladding layer 403, and p mold electrode 421 is formed on the contact layer 406.
[0108] This semiconductor laser component is the following, and can be made and produced.
[0109] first, a silicon-on-sapphire 401 top -- MOCVD -- the GaN buffer layer 402 (0.05 micrometers of thickness), the 1st cladding layer 403 of GaN, the non dope single quantum well barrier layer 404, the 2nd cladding layer 405 of aluminum0.2Ga0.8N, and the p-GaN contact layer 406 (micrometers [of thickness / 0.2], Dopant Mg, carrier concentration 5x1017cm-3) are grown up by law.
[0110] Here, the single quantum well barrier layer 405 grew up the Ga0.2In0.8P quantum well layer (0.003 micrometers of thickness) of a monolayer. And the 1st cladding layer 403 grew up the impurity non-adding layer (0.03 micrometers of thickness), and the impurity addition layer (2.97 micrometers of thickness, Dopant Si, carrier concentration 5x1018cm-3) from the barrier layer 404 side. And the 2nd cladding layer 405 grew up the impurity non-adding layer (0.05 micrometers of thickness), and the impurity addition layer (0.05 micrometers of thickness, Dopant Mg, carrier concentration 5x1017cm-3) from the barrier layer 404 side.
[0111] The heat history temperature under above-mentioned MOCVD growth (crystal growth temperature) is 900 degrees C - 1100 degrees C, and thereby, in the 1st cladding layer 403, the impurity diffusion from an impurity addition layer to impurity a non-adding layer happens, and it is divided into the impurity rare field 410 (0.01 micrometers of thickness), the impurity middle concentration field 411 (0.02 micrometers of thickness), and the impurity addition field 412 (2.97 micrometers of thickness) from a barrier layer 404 side. On the other hand, in the 2nd cladding layer 405, the impurity diffusion from an impurity addition layer to impurity a non-adding layer happens, and it is divided into the impurity rare field 413 (0.02 micrometers of thickness), the impurity middle concentration field 414 (0.04 micrometers of thickness), and the impurity addition field 415 (0.04 micrometers of thickness) from a barrier layer 404 side. Therefore, an impurity addition field, an impurity middle concentration field, and an impurity rare field are produced in a brief process with a sufficient controllability by the heat history in the crystal growth of a semi-conductor layer.
[0112] Then, it etches, the 1st cladding layer 303 is exposed in part, and n mold electrode 420 and p mold electrode 421 are respectively formed on the outcrop and the contact layer 406.
[0113] Thus, with the light emitting diode component of this operation gestalt 5, thickness of an impurity a non-adding layer is made thicker than n mold cladding layer side by p mold cladding layer side, and since the diffusion coefficient is larger than n mold impurity, p mold impurity can adjust the value of an impurity rare field to desired thickness. Thereby, since the thickness of an impurity rare field can be adjusted according to a diffusion coefficient, it has the advantage that the degree of freedom of the design for realizing property degradation prevention under low operating voltage and energization improves.
[0114] When forward voltage was impressed between n mold electrode 420 and p mold electrode 421 to the light emitting diode component of this operation gestalt 5, the luminescence wavelength of 0.45 micrometers, 50mA of operating currents, and operating voltage 4.5V were obtained.
[0115] In addition, this invention is not limited to the above-mentioned operation gestalt, and this invention can apply the configuration (the number of quantum wells, a mixed-crystal ratio, and thickness) of a quantum well barrier layer, the thickness of each class, aluminum mixed-crystal ratio and a dopant kind, and carrier concentration also about a different semi-conductor light emitting device from ****.
[0116] a grown method -- MOCVD -- it restricts to law -- not having -- MBE (molecular beam epitaxy) -- law and LPE (liquid crystal epitaxy) -- law and MOMBE -- law and ALE (atomic-line epitaxy) -- law etc. may be used. Moreover, although the impurity middle concentration field was formed by the impurity diffusion from an impurity addition field to impurity a non-adding field, you may grow up a semi-conductor layer independently. Moreover, in order to control diffusion, compared with the growth

temperature of a barrier layer, about 50 degrees C - about 200 degrees C of growth temperature of an impurity middle concentration field may be made low.
[0117] Furthermore, this invention is applicable also about the case where other ingredient systems except having mentioned above are used.
[0118]
[Effect of the Invention] Since it can control that an impurity is spread from an impurity addition field to a barrier layer during energization by the impurity rare field established in the cladding layer or the lightguide layer when based on this invention as explained in full detail above, increase of the operating current can be controlled, degradation of a component property can be prevented, and a reliable semi-conductor light emitting device can be obtained. Since resistance of the whole lightguide layer can be lowered by the impurity addition field and the diffusion potential between a lightguide layer and a cladding layer can be further reduced with it, operating voltage can be reduced.
[0119] When based on claim 4 of this invention, by the impurity middle concentration field prepared between the above-mentioned impurity rare field and the impurity addition field, during energization, it can protect that an impurity is spread to an impurity rare field from an impurity addition field, and the dependability of a component can be raised further.
[0120] Since a barrier layer consists of a quantum well layer, layer structure changes also with the slight impurity diffusion under energization and it is easy to produce property degradation when especially based on claim 5 of this invention, it is possible to raise the dependability of a component sharply.
[0121] When based on claim 6 and claim 7 of this invention, while reducing operating voltage effectively by setting respectively the high impurity concentration in the impurity addition field of p mold of the above-mentioned lightguide layer, and n mold as the predetermined range, property degradation by the nonluminescent recombination of the carrier in an impurity addition field can be controlled effectively.
[0122] When based on claim 8 of this invention, the impurity diffusion to the barrier layer under energization can be effectively controlled by making carrier concentration of the impurity in the above-mentioned impurity rare field or less [of the carrier concentration of the impurity in an impurity addition field] into 1/5.
[0123] When based on claim 9 of this invention, while controlling property degradation effectively, operating voltage can be effectively reduced by setting thickness of the above-mentioned impurity rare field to 3nm or more 10nm or less.
[0124] When based on claim 10 of this invention, by establishing the above-mentioned impurity rare field in p mold cladding layer or p mold lightguide layer side at least, a component design can be made easy and the yield of manufacture can be raised.
[0125] When based on claim 11 of this invention, although are prepared in p mold cladding layer or p mold lightguide layer among the above-mentioned impurity rare fields and thickness was prepared in n mold cladding layer or n mold lightguide layer, by making it thicker than thickness, the controllability over a component design can be raised and the manufacture yield can be raised.
[0126] When based on claim 12 of this invention, since it can protect that an impurity is spread from an impurity addition field effectively to an impurity rare field, and the dependability of a component can be raised during energization and carrier injection to a barrier layer is not prevented from an impurity addition field, operating voltage can be reduced by setting the thickness of the above-mentioned impurity middle concentration field as 3nm or more 10nm or less.
[0127] When are based on claim 13 of this invention and the above-mentioned barrier layer consists of a multiplex quantum well layer, at least, by making smaller than the forbidden-band width of face of a barrier layer forbidden-band width of face of the above-mentioned impurity addition field larger than the forbidden-band width of face of a quantum well layer, aluminum mixed-crystal ratio can be made small and the impurity diffusion from an impurity addition field to a barrier layer can be reduced further. In this case, since the thickness of an impurity rare field can be set up thinly, it can decrease enough also about operating voltage.
[0128] Since aluminum mixed-crystal ratio of an impurity addition field can be made still smaller by

making forbidden-band width of face of an impurity addition field smaller than the forbidden-band width of face of an impurity rare field when based on claim 14 of this invention, the dependability of a component can be raised further.

[0129] Especially when based on claim 15 of this invention, diffusion of an impurity can be prevented also in the AlGaInP system ingredient or InGaN system ingredient with which impurity diffusion tends to happen, and the dependability of a component can be raised.

[0130] Since an impurity is diffused from an impurity addition layer to an impurity additive-free layer by the heat history in crystal growth and an impurity middle concentration field is formed when based on claim 16 of this invention, an impurity addition field, an impurity middle concentration field, and an impurity rare field are producible in a brief manufacture process with a sufficient controllability. Therefore, the dependability of a component is high and operating voltage becomes possible [offering a low semi-conductor light emitting device by low cost].

[0131] When based on claim 17 of this invention, although are prepared in p mold cladding layer or p mold lightguide stratification section among the above-mentioned impurity additive-free layers and thickness was prepared in n mold cladding layer or n mold lightguide stratification section, a controllability can improve thickness of an impurity rare field desired thickness by making it thicker than thickness. Therefore, the controllability over a component design can be raised and the yield can be raised further.

[Translation done.]